

Brookhaven Graphite Research Reactor Workshop

May 9 and 10, 2007

BGRR Location at BNL



BGRR Complex



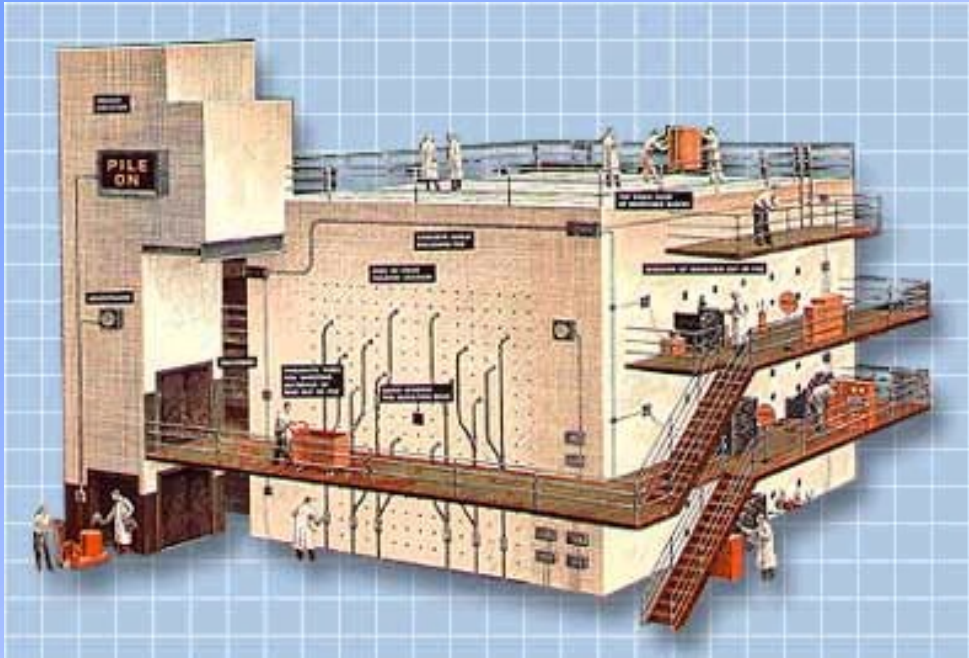
Brookhaven Science Associates
U.S. Department of Energy

BGRR General Background

- First reactor built for peacetime research on the atom
- Located in the center of BNL site
- Accomplished great science from 1950 to 1968
- All fuel removed in 1972
- BNL Science Museum 1977 to 1997
- Decommissioning efforts began in 1997 upon discovery of contaminated water in below-ground ducts



Graphite Research Reactor



Reactor is 25 by 25 foot cube of graphite.

Fueled by uranium fuel rods, cooled by circulating air

Surrounded on sides and top by five foot thick steel encased concrete walls to shield researchers from radiation.

Decommissioning Actions to Date

- Removed water in the pile fan sump, east yard sump and the below ground ducts (60,000 gals)
- Extensive radiological and hazardous material characterization of BGRR structures, system and soils
- Equipment, pipes, fans, pile-fan sump removed
- Above-ground ducts and equipment removed
- Canal and water-treatment house equipment removed
- Below-ground duct-cooling coils, filters and primary liner removed
- Total of 50 Curies of contamination removed to date

Removal of Pile Fan Sump



- 5'x7'x10' Deep Concrete Vault
- Excavated surrounding soil
- Removed in one piece



Removal of Canal and Water Treatment House



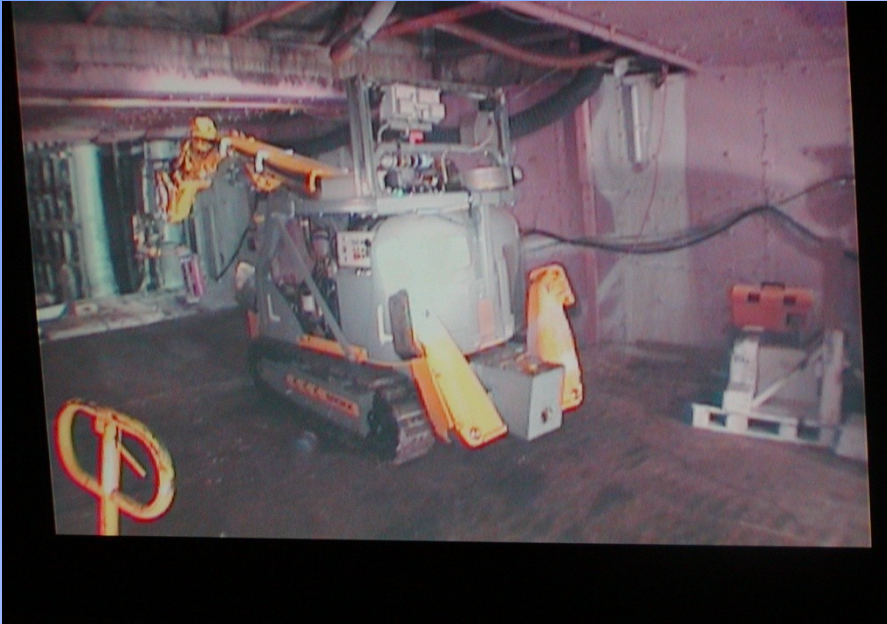
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Removal of Above-Ground Ducts

- ~200' of ducting
- Segmented into 12 pieces
- Largest piece ~300,000 lbs



Below-Ground Duct Coolers, Filters and Primary Liner Removal



Filter Removal



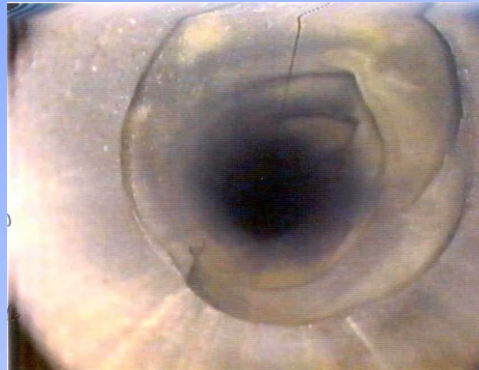
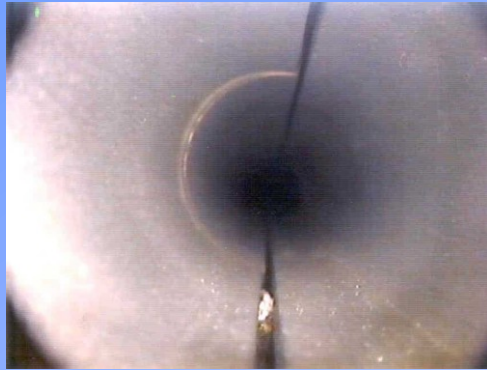
Liner Removal

BGRR History

- Historic operation logs indicated several fuel failures
- Performed video inspection of fuel channels
- Obtained radiological characterization data

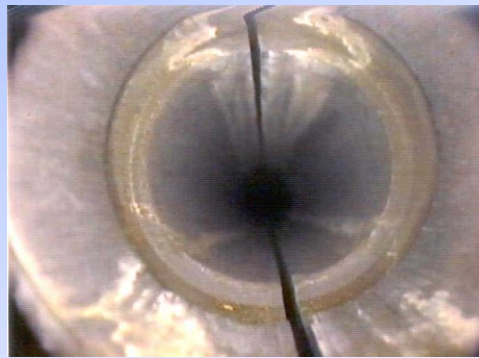


BGRR History



Distorted fuel channels

Gaps in graphite mating surfaces

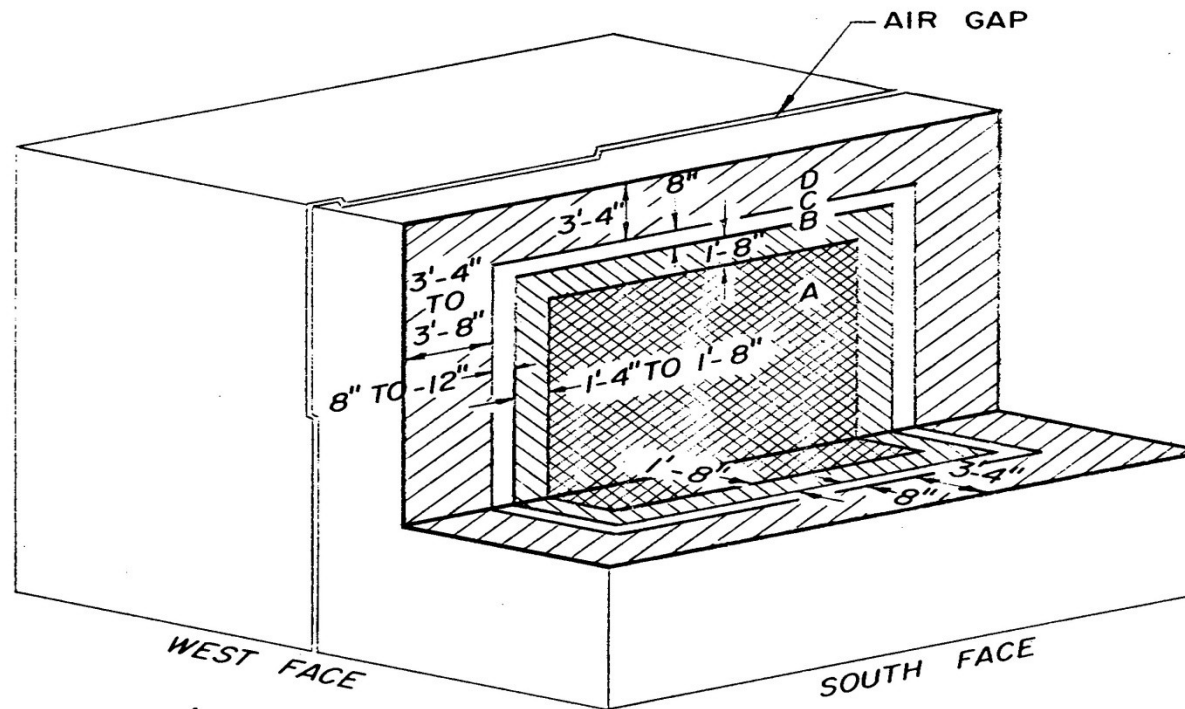


Caused by excessive heat
of failed nuclear fuel

Characterization Data

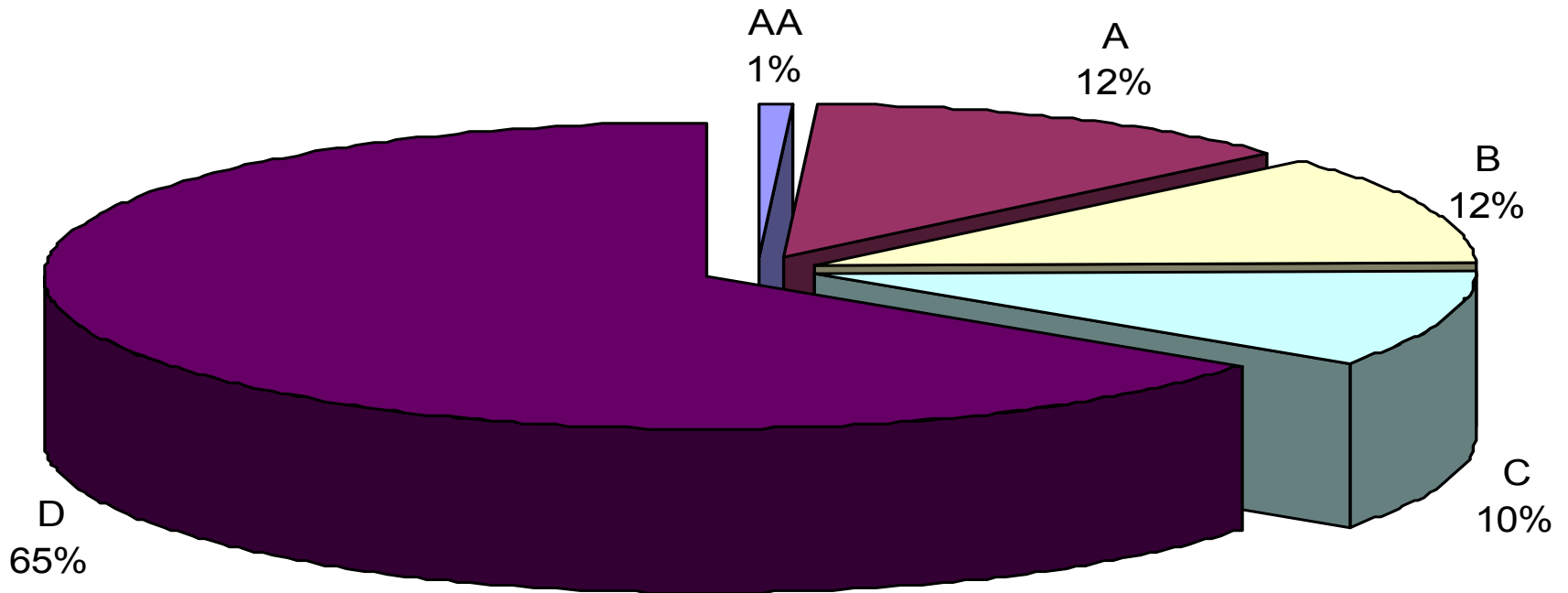
- Graphite
- Biological Shield
- Control Rods
- 701 Building

Characterization Data - Graphite Types (A, B, C, D)



LOCATION OF
FOUR GRADES OF GRAPHITE
FIG. GO4.OI-12

Characterization Data - Graphite Types: Percentage by Weight



Total Graphite
Weight =
1,460,000 lb.

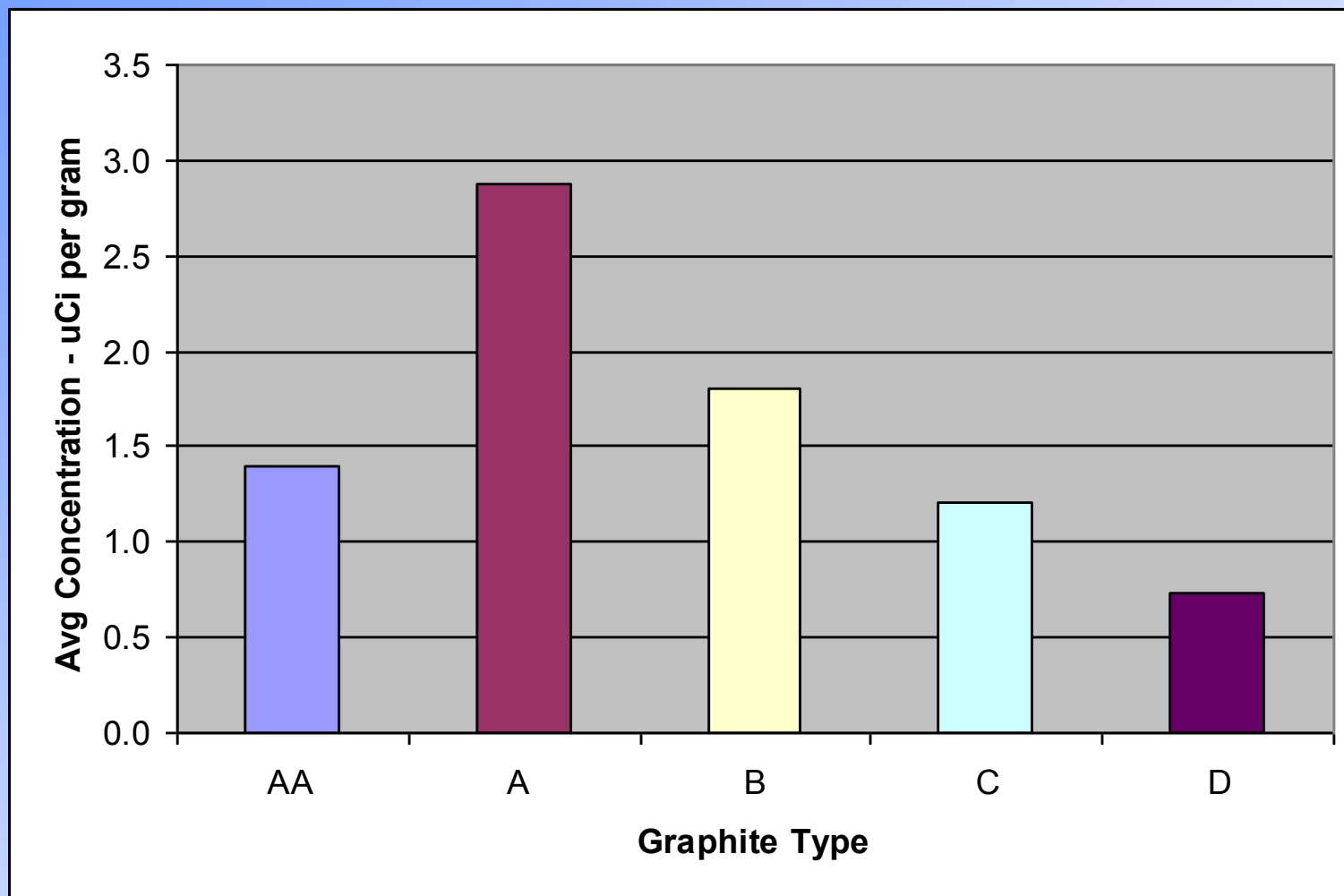
Characterization Data - Graphite Inventory

Nuclide	Curies	Percent
C-14	571	73%
Ni-63	97	12%
H-3	78	10%
Eu-152	21	3%
Total Activity	786 (all nuclides)	

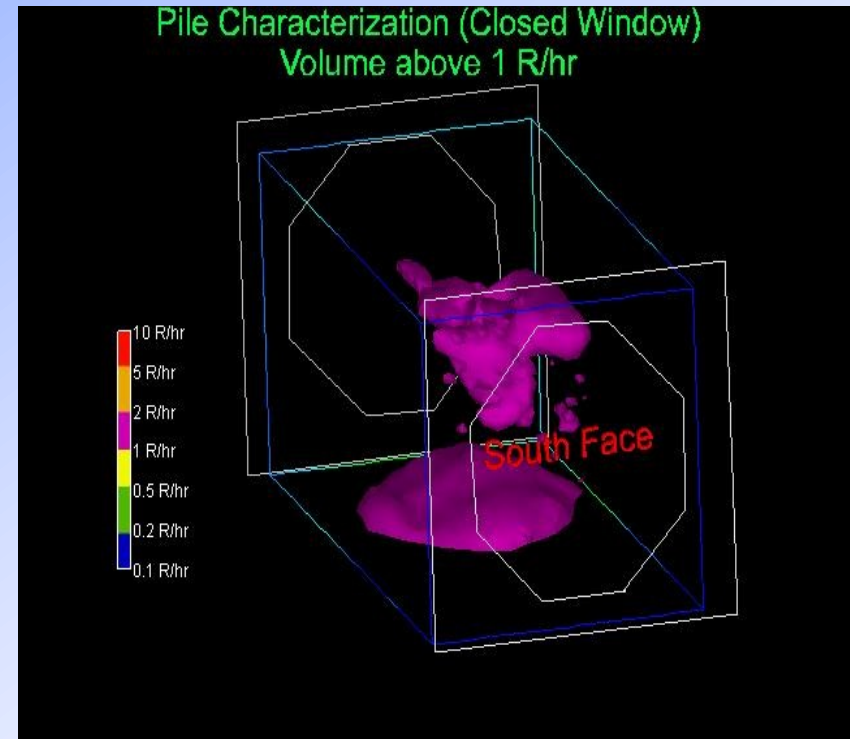
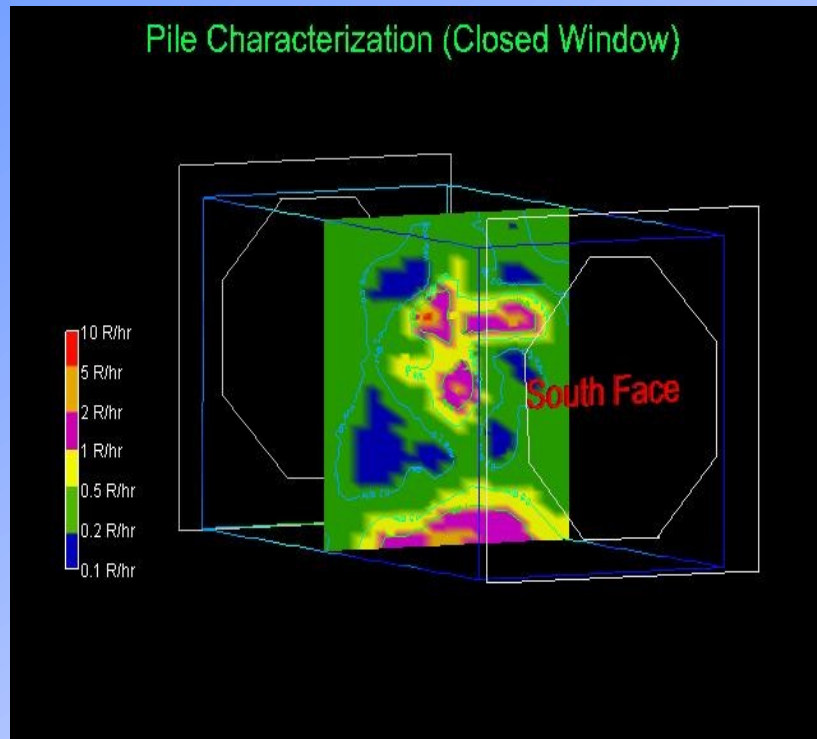
Total Graphite Weight = 1,460,000 lbs

TRU = 0.25 Ci (0.36 nCi/gram)

Characterization Data - Graphite Average Concentration



Internal Pile Dose Rates (Year 2000)



Note: Maximum dose rate detected 80 R/hr

Characterization Data - Bioshield

- Estimated inventory – 81 Curies
- Outer wall dose rates < 1mR/hr
- Inner dose rates undetermined due to high background from pile

Characterization Data – Bioshield Inventory

- Outside steel samples indicated no activation of the metal
- Outermost 2 feet of concrete indicated no activation
- Surveys and sample data support the assumption of essentially symmetrical activation of the bioshield walls.
- Primary radionuclides in the activated steel are Ni-63 (62%), Co-60 (32%), Fe-55, and Ni-59.
- The primary radionuclides in the activated concrete are H-3 (98%), Eu-152, Ni-63, and Co-60

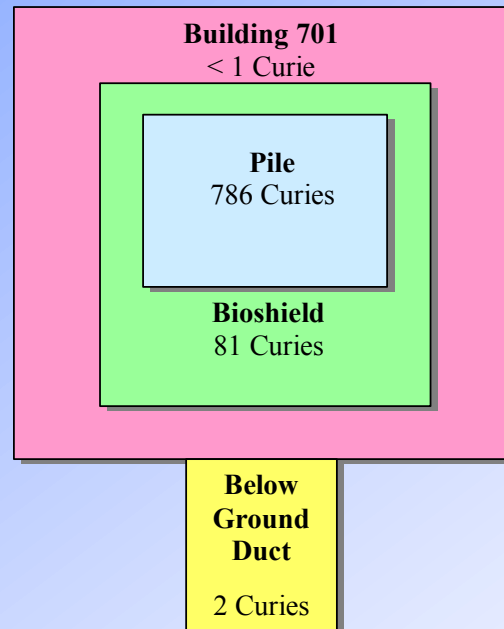
Characterization Data – Control Rods

- Two control rods characterized with max. dose rate @70mr/hr
- In-Situ Object Counting (ISOCS) analysis (gamma spectroscopy) indicated mostly Co-60

Characterization Data – Building 701

- General area dose rates < 0.50 uR/hr
- Elevated dose rates found around contaminated equipment (e.g. Brokk manipulator) and bioshield penetrations
- Most areas are free of loose contamination - contaminated areas limited and are radiologically posted

BGRR Summary Characterization



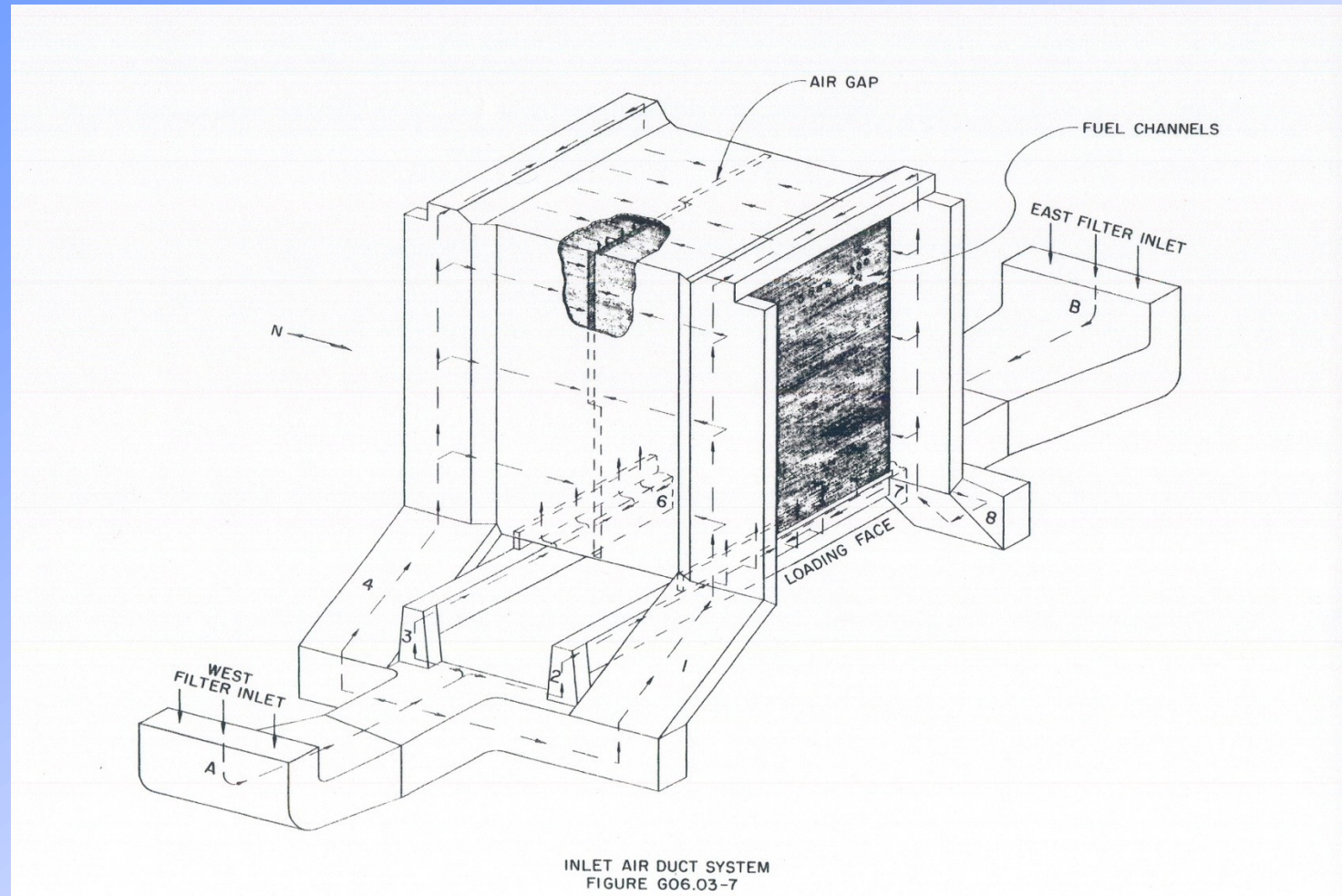
Pile Construction

- The Brookhaven Graphite Research Reactor was a heterogeneous, enriched, uranium-fueled graphite-moderated and reflected, thermal neutron, air-cooled research facility
- The reactor consists of a 25-foot graphite cube weighing approximately 700 tons, built in two halves separated by a vertical gap running east and west
- Filtered cooling air was brought into the gap and flowed through the individual channels removing heat from the fuel and the graphite

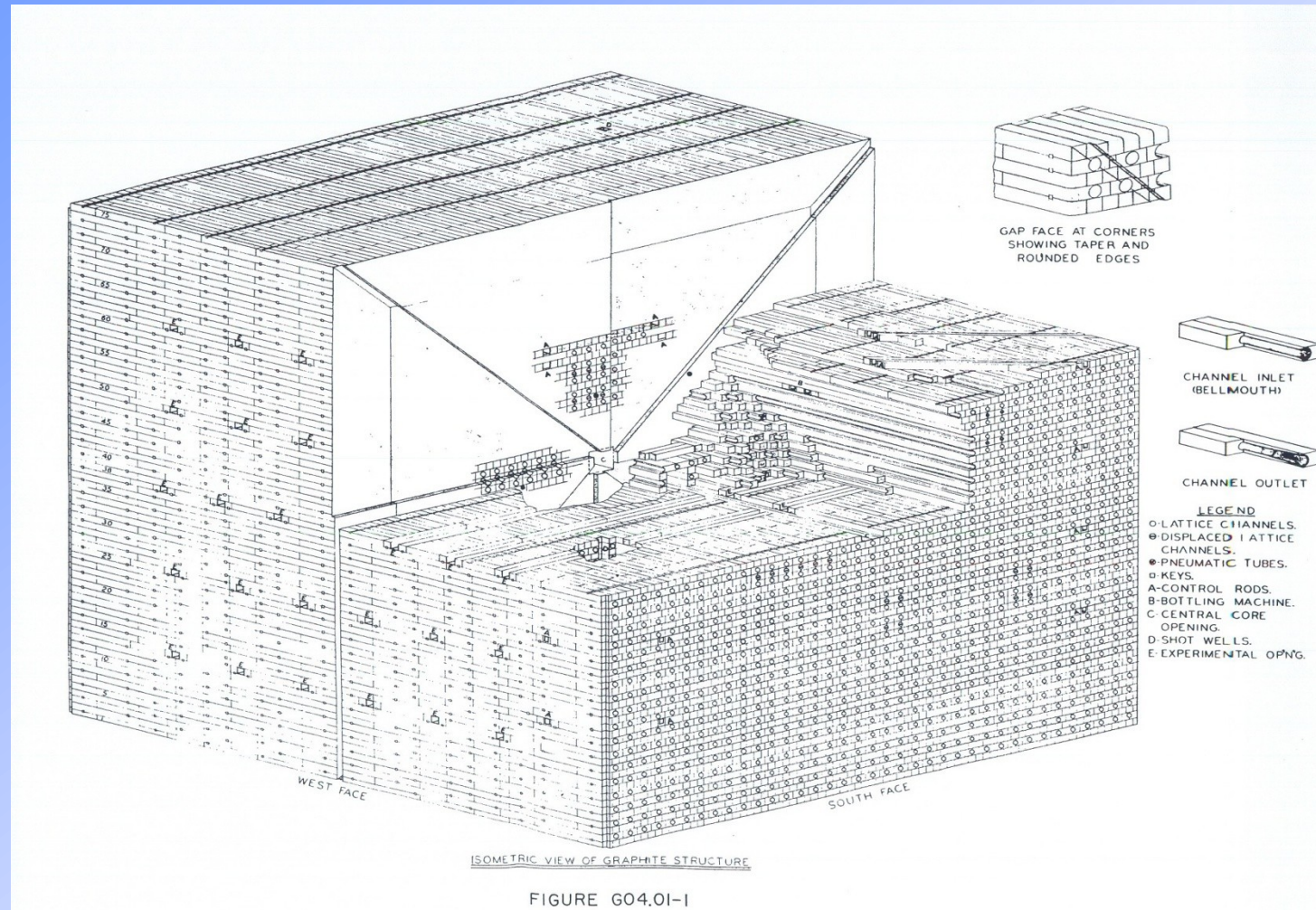
Pile Construction

- Fuel elements were charged and discharged through the south face by means of suitable openings in the shielding which matched the graphite channel openings.
- The other four faces of the reactor are penetrated by an assortment of experimental openings.
- There are a total of 1,368 fuel channels that run north-south, 30 experimental ports that run east-west, removable shield plugs on the top of the reactor along with two scanner slots on the south side, and one scanner slot on the north side.

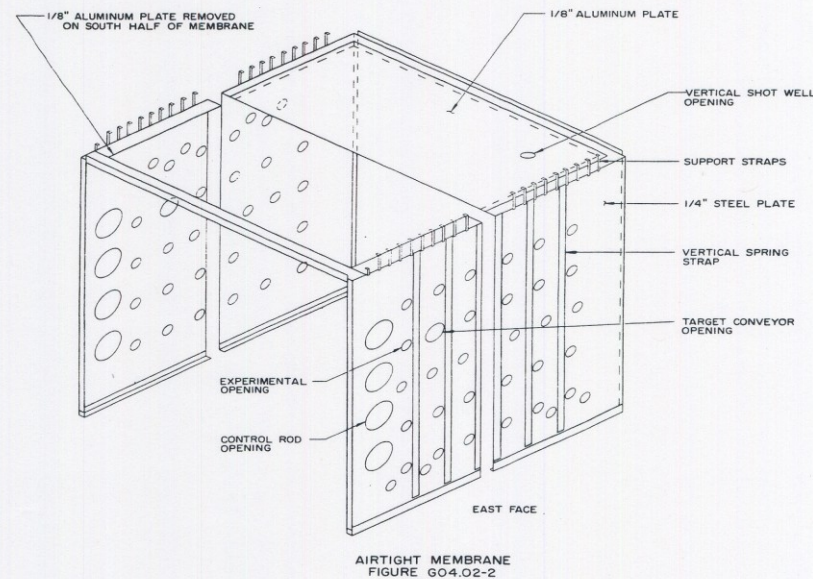
Inlet Air Flow



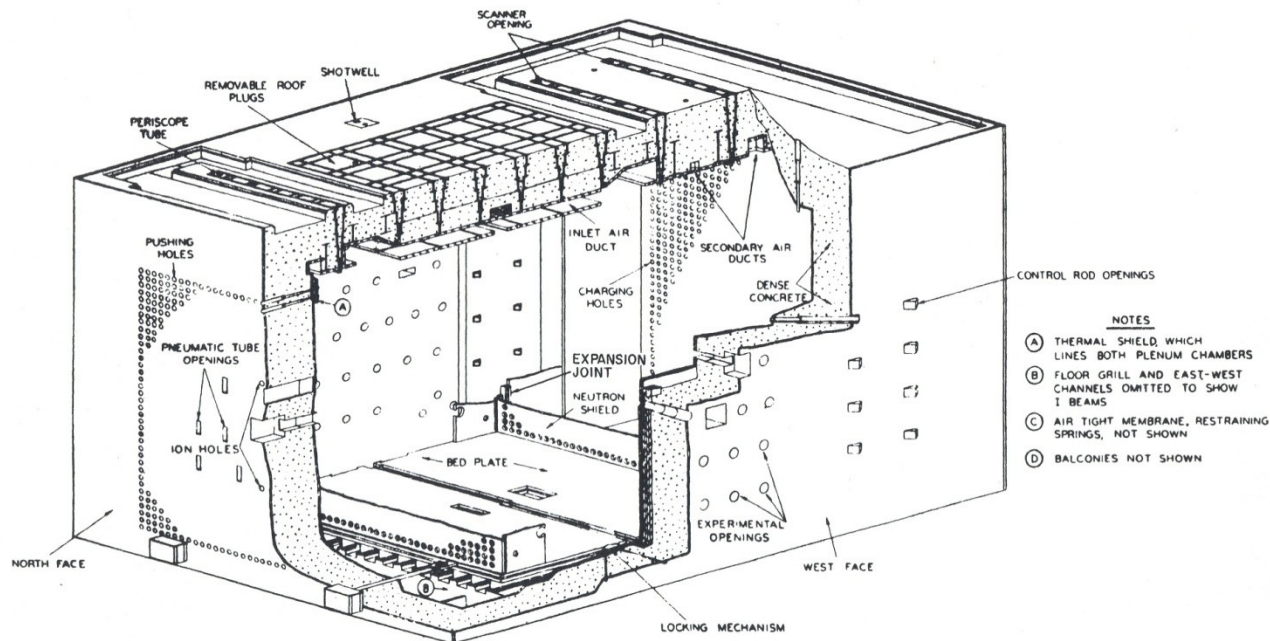
Pile Construction



Pile Construction



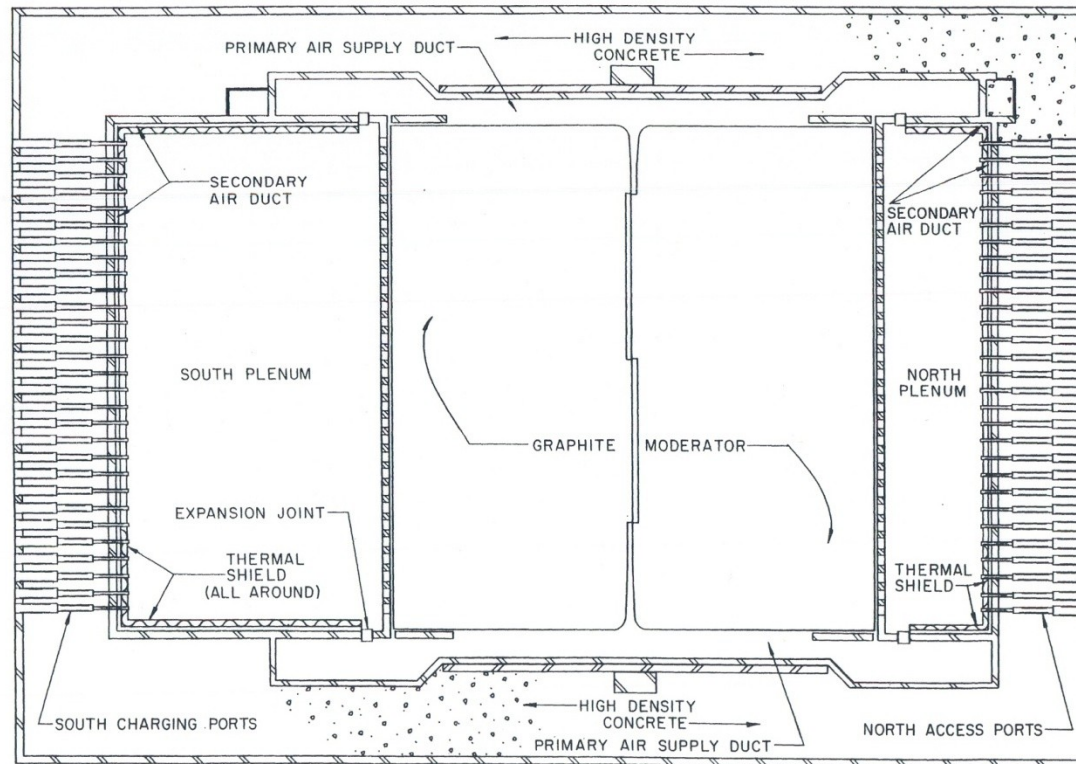
Pile Construction



CUTAWAY ISOMETRIC VIEW OF SHIELD

FIGURE G04.02-3

Pile Construction



PLAN OF REACTOR
FIGURE G04.02-1

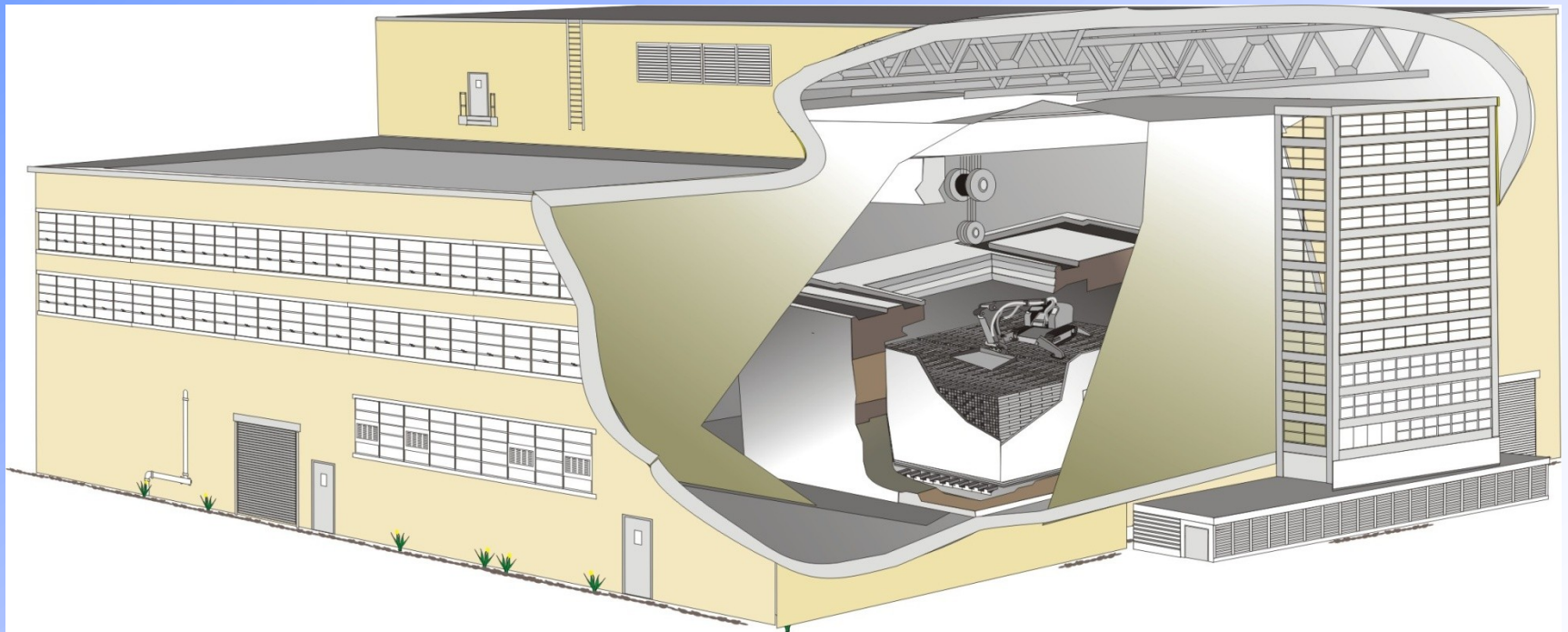
Pile Removal Scope of Work

- Removal of boron shot (approx. 1000 pounds)
- Removal of the 16 control rods from the graphite pile and package for disposal.
- Removal of the removable concrete plugs from the top of the BGRR biological shield to access the graphite pile. The concrete plugs will be packaged for disposal.
- Removal of the air membrane to access the pile
- Remove graphite pile (approx. 60,000 blocks) down to steel bedplates and package for disposal.

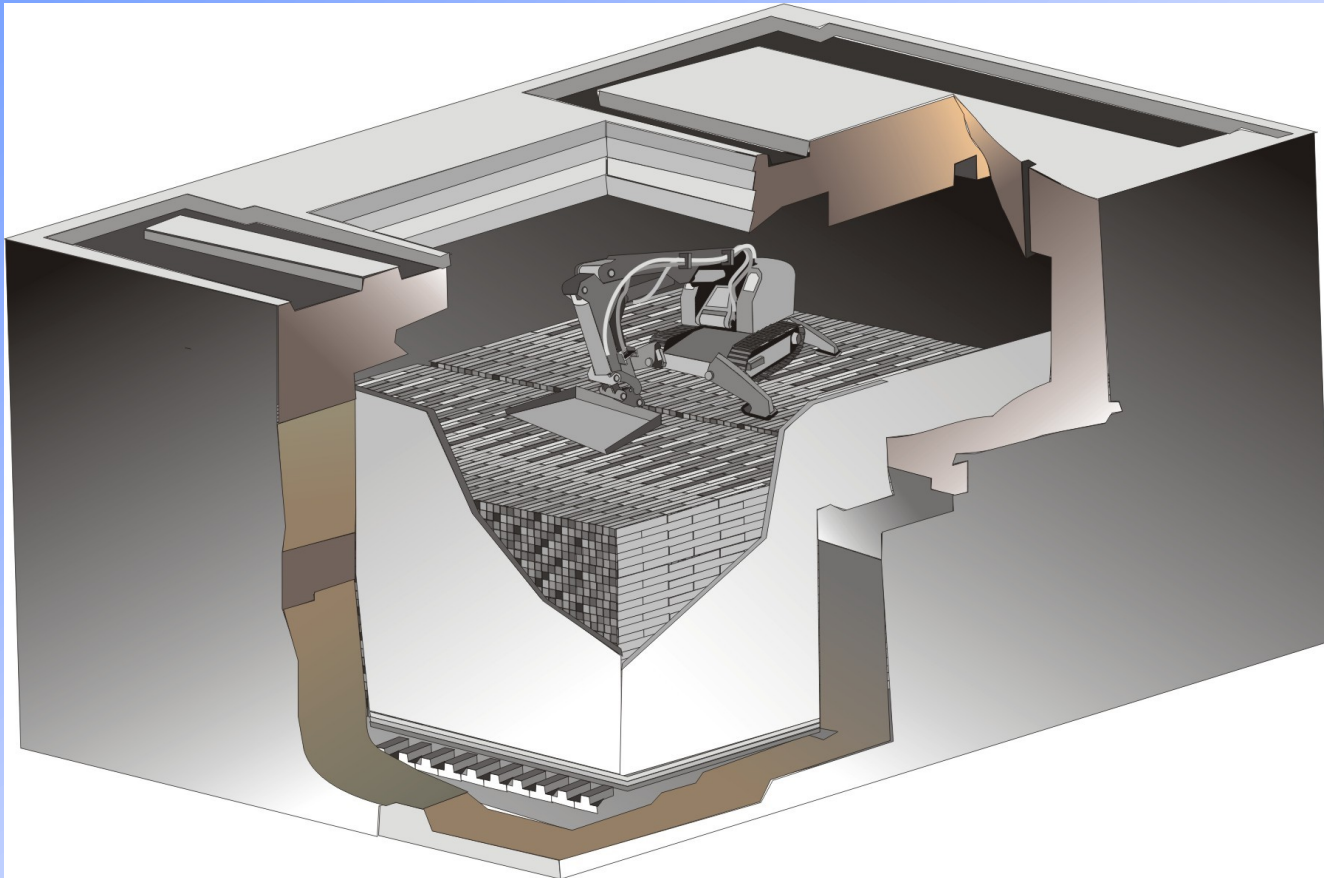
BGRR Planned D&D Activities (Pile)

- Graphite blocks to be placed into soft-sided bags (supersacks) inside bioshield cavity.
- Supersacks removed from bioshield cavity placed into 144 ft³ boxes.
- Boxes to be lowered with Bldg. 701 crane to elevation 110' (staging spot or directly onto flatbed)
- Estimated total of 195 boxes

BGRR Conceptual Graphite Removal



BGRR Conceptual Graphite Removal



Bioshield Construction

- 55 feet long by 37 feet 6 inches wide by 33 feet 7 inches high
- 5' steel and concrete structure (5000 tons)
- Inner wall of 6" carbon steel
- 4' 3" high density concrete
- Outer wall of 3" carbon steel

Bioshield Scope of Work

- Removal of north and south neutron shields (3 inches of activated carbon steel).
- Remove inner steel wall (6 inches activated carbon steel).
- Remove 4.25 ft of concrete.
- Remove outer steel wall (3 inches carbon steel - not activated)

BGRR Planned D&D Activities (Bioshield)

- Install HEPA-filtered containment around bioshield from overhead rafters to bottom of Building 701 (el. 143')
- Use mechanical, track mounted milling machines to cut out inner carbon steel
- Place pieces inside intermodal containers
- Dismantle concrete using Brokk or equivalent machine
- Fill supersacks with concrete debris
- Remove outer wall with thermal cutting techniques
- Concrete pour of bioshield cavity to bottom bedplates

Concrete Demolition with Brokk Machine



Pile Waste Management

- Graphite waste shall be packaged in “supersacks” (soft-sided containers) and placed into 144 cubic foot metal boxes.
- Total boxes estimated to be 195
- Meet burial site criteria (Waste Acceptance Criteria)
- Ship by truck (91 shipments) to Nevada Test Site (NTS)
- Some boxes are anticipated to require shielding (approx.39)
- Packaged waste will meet Department of Transportation shipping requirements

Bioshield Waste Management

- Concrete waste shall be packaged into 650 “supersacks” (soft-sided containers) and placed into “gondola” rail cars (approx. 44 gondolas)
- Activated steel will be placed into 33 “intermodal” steel boxes and placed onto flatbed rail cars (approx. 8).
- Meet burial site criteria (Waste Acceptance Criteria)
- Ship by rail to commercial burial facility (Energy Solutions in Clive, Utah)
- Packaged waste will meet Department of Transportation shipping requirements

Transport by of Low Level Radioactive Waste Boxes by Truck



Transport of Low Level Radioactive Waste by Rail Car



Nevada Test Site – Disposal Of Radioactive Waste Boxes



Health and Safety Requirements

- Commitment/highest priority to personnel safety
- Removal design does not entail entries into pile cavity (As Low As reasonably Achievable - ALARA)
- Tool design, personnel training, mock-up testing and approval
 - BSA will closely monitor the design and testing of all tools in accordance with the approved Design and Qualification Plan for Special Tools and Equipment
 - A job training assessment will be performed jointly by BSA and the contractor and 100% of the required training shall be completed prior to the commencement of work
- Robust ventilation system for dust control and to prevent environmental release
- BGRR Safety Basis is Category 3 Nuclear Facility – stringent adherence to Technical Specification Requirements (TSRs)

Questions?